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Assessment of Post-Harvest Loss of Milk and Milk Products and Traditional Mitigation Systems in Mekelle Milk Shed, Northern Ethiopia

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Abstract
The study was conducted in purposively selected dairy potential districts located in and around Mekelle milk shed areas to assess traditional production, handling and processing, milk post-harvest loss and its mitigation system in small-scale dairying. Multi stage stratified random sampling method was employed to select locations within districts and households. Semi-structured questionnaire was used to interview 79 milk producers. The data was analyzed using Statistical Procedures for Social Sciences (SPSS) version20. Milking is mostly done by men (75.9%) where as milk handling (79.5%), processing (88.6%) and marketing (57%) were primarily handled by wives. The majority of respondents (89%) used plastic bucket for milking while clay pot was used for milk fermentation (22.1%). Producers mainly used *Acacia etbaica and Olea africana* to fumigate milk and milk product containers for improving flavor while others to increase shelf life. The main possible reason for milk spoilage problem was poor milk handling practices in the area (78.7%). The major milk production constraints were feed shortage (57%), unavailability of improved breeds (60.8%), poor veterinary service (38%), poor quality of feeds (57%) and associated low milk yield (38%). Therefore, it is vital to strengthening linkage with extension services in the study areas to enhance input provision, milk production, handling, processing, marketing and consumption. High yielding improved breeds through improving the current AI delivery system will have paramount importance to boost the current milk production in the area. Enhancing the veterinary services, availability of improved forage, infrastructure and training of different value chain actors on different aspects of milk production is also necessary.
Keywords: post harvest, handling, milk, production

Introduction

The total livestock population of Ethiopia is estimated to be 56.7 million cattle, 29.3 million sheep, 29.1 million goats, 2 million horse, 7.4 million donkey, 0.4 million mule, 1.2 million camel and 56.9 million poultry. Out of the total cattle population, about 98.7 % are indigenous while hybrid and exotic breeds accounted for about 1.2% and 0.14%, respectively (CSA, 2014). Despite the existing high potential for dairy development due to huge livestock resources and favorable climatic conditions the performance of the dairy industry in the country has not been encouraging. However, an increase in the global population coupled with the increasing demands for milk as an economic food and as an industrial raw food product has required an increase in production by dairy farms (Habtamu *et al*., 2012). The demand in consumption of milk and milk product is steadily increasing in the country. Given the considerable potential for smallholder income and employment generation from high-value dairy products (Staal, 2002), the development of the dairy sector, can significantly contribute to poverty alleviation and nutrition in the country.

Milk spoilage is a major problem of the dairy sector in tropical countries. The high temperature coupled with absence of cooling facilities and lack of adequate transportation means accelerate the spoilage of the milk produced in this area (O'Mahoney and Peters, 1987). In Ethiopia the rural milk production system accounts for about 97% of the total milk production in the country where it is difficult to transport the raw milk to the market areas or to the processing plants due to poor infrastructure (Staal and Shapiro, 1996). Only about 5 % of the milk reaches to the market areas and the rest of the milk is processed at the farm into different dairy products. A significant amount of milk is spoiled due to the absence of cold storage facility such as refrigeration.

Milk processing is one of the mitigation systems used to minimize the loss of raw milk especially in areas where infrastructure is underdeveloped to sale raw milk. Assessment of the quality of traded milk and milk products has shown that value addition through small-scale processing is important for income generation and reduction of post-harvest losses (Lusato, 2006). In Mekelle milk shed area, different methods have been practiced by small scale milk producing households to mitigate post-harvest milk losses. However, the main causes for milk spoilage problem, proportion of milk lost due to several reasons and the traditional methods to preserve milk and its products were not well studied and documented. Therefore, the objectives of the present study were to assess traditional production, handling and processing, estimation of postharvest loss of milk and traditional mitigation system in small-scale dairying.

Materials and methods

Study areas

The study was conducted in Adigudom, Merebmiet, H/selam, Wukro and Debri (within 45 kilometers surrounding Mekelle milk shed). Mekelle is the capital city in the northern Tigray region of Ethiopia. It is located around 780 kilometers north of the Ethiopian capital Addis Ababa, at a latitude and longitude of 13°29'N 39°28'E, with an elevation of 2084 meters above sea level.

Multi stage stratified random sampling method was employed to select locations within districts and households. Semi-structured questionnaire was used to interview 79 milk producers. In addition to standard questionnaire survey, check lists was prepared to evaluate handling, processing and storage of milk and milk products along the value chain by visual observation. Statistical Procedures for Social Sciences (SPSS) version 20 (SPSS, 2011) was employed to analysis the data.

Result and Discussion

Division of Labor in Milk Handling, Processing and Marketing in Mekelle Milk shed

According to the present study the respondents reported that milking was mainly done by men while milk handling, processing and marketing were primarily handled by wives (Table 1). This is in agreement with Minale and Yilkal (2015) who reported that in Chencha and Kucha districts of South Ethiopia women took highest position in processing of milk. However, Alganesh (2002) reported that women exclusively do milking and processing of milk into different products and men never milk the cows in East Wollega zones. Similarly, in urban and peri-urban of shashemen-Dilla milk shed milking is mainly handled by women (79.3%) followed by hired labour (9.3%), while the role of men and children is insignificant (Azage *et al;* 2013).

Table1. Gender analysis (division of labor among family members) on milking, milk handling, processing and marketing (%)

Activity description	Adigudom	Debri	H/selam	Merebmiet	Wukro	Over all
Milking						
Husband	83.3	76	78.6	60	77.8	75.9
Wife	16.7	24	14.3	10	5.6	16.5
Both wife &husband	58.3	44	57.1	30	55.6	49.4
Sons and daughters	25	24	7.1	20	11.1	17.7
Milk handling						
Husband	33.3	8	14.3	10	27.8	17.7
Wife	58.3	83.3	85.7	100	72.2	79.5
Husband and wife	25	44	7.1	20	33.3	29.11
Sons and daughters	16.7	8	0	0	0	5.1
Milk processing						
Husband	33.3	8	7.1	0	16.7	12.7
Wife	83.3	96	85.7	100	77.8	88.6
Sons and daughters	8.3	12	7.1	20	16.7	12.65
Marketing						
Husband	58.3	60	71.4	20	50	54.4
Wife	50	52.2	57.1	90	50	57.1
Both wife &husband	16.7	24	14.3	0	11.1	15.2
Sons and daughters	8.3	0	0	0	16.7	5.1

Materials used for Milking and Milk Fermentation

Milk handling equipments and the proportion of households used the equipments is presented in Figure 1. The majority of respondents (87%) were used plastic bucket for milking while clay pot was used for milking (1.3%) and stainless steel (3.9%). This is similar finding to Zelalem (2010) who reported that 81% and 3.4% of the respondents from ten dairy potential areas in the Ethiopia highlands used plastic jars and stainless equipment's, respectively, while 6.6% of them used clay pot. Other study also reported that 72.2% of the respondents in Mid Rift Valley area of Ethiopia used plastic bucket and 17.0% metallic equipment for milking purpose (Fikernehe *et al*., 2012). Likewise, Sintayehu *et al.,* (2008) reported the majority (92%) of urban producers Shashemene–Dilla area used plastic milk utensils. While Azage *et al*., (2013) reported that in the rural highland production system of Bure and Fogera areas most farmers used gourds for milking and in the urban dairy production system most dairy farmers (92%) used plastic utensils.

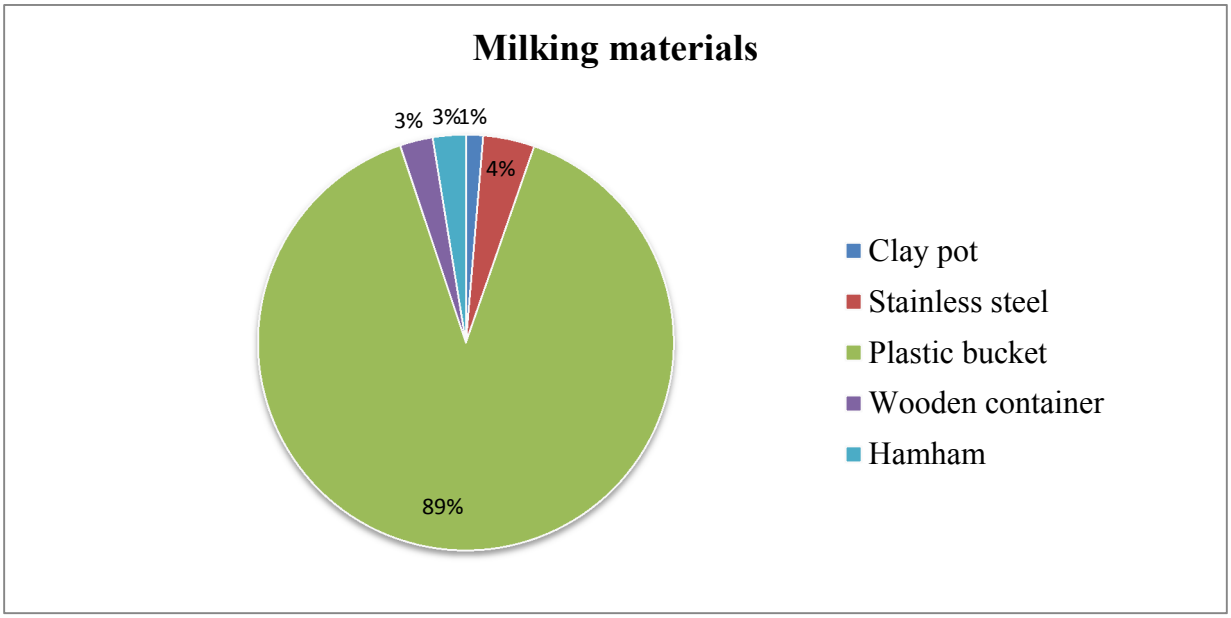

Figure1. Materials used for milking purpose

Figure2 shows materials used for fermentation purpose in the studied areas. For milk fermentation purpose 68.4% of producers used plastic bucket and 22.1% of producers used clay pot. In contrary to this study, Shewangizaw and Addisu (2014) reported materials used for milk and milk fermentation in Wolayita Sodo was primarily clay pot and secondly plastic bucket. Yitaye (2008) also reported that majority of the peri-urban producers in the northern highlands of Ethiopia used gourd (69%) and the rest (48%) used clay pot utensils. Similarly Fikirnehe *et al*, (2012) also reported that about 31.5% and 12.0% farmers in the mid rift valley of Ethiopia were using plastic and metallic equipments for the storage or fermentation of milk. On the other hand, Minale and Yilkal, (2015) indicated the majority (92.5%) and (97%) of the milk producing households in Chencha and Kucha districts of Southern Ethiopia used clay pot for storage of milk to extract butter.

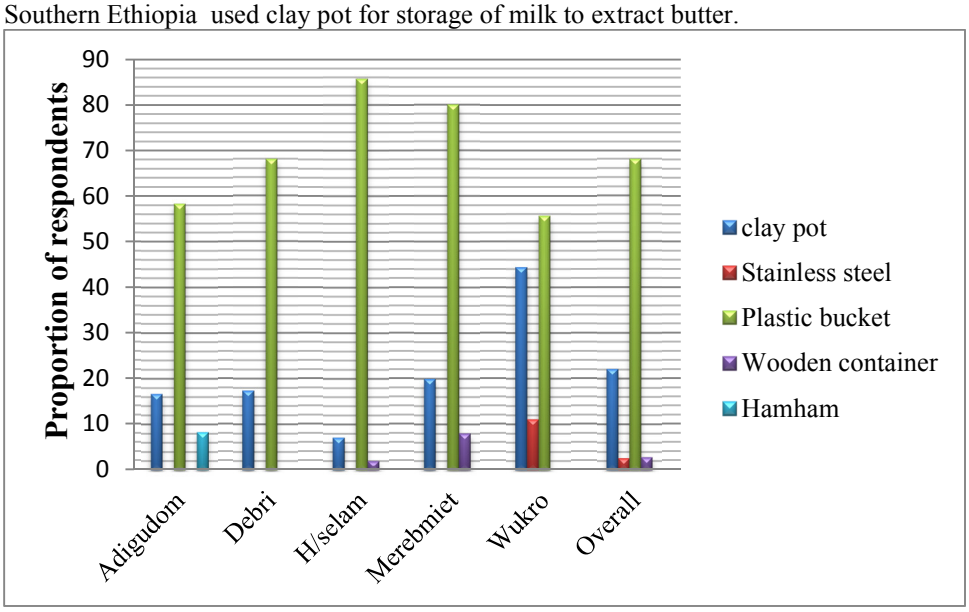

Figure 2. Materials used for milk fermentation purpose

Milk and milk products preservation and shelf life

The overall mean duration of milk fermentation/souring before churning were 3.12±.1days. Similar trends reported in semi-arid Borana plateau of Ethiopia where milking is typically stored to produce fermented milk for five days (Alganesh, 2002). In this study the majority of interviewees (89.9%) rub their milking equipments for washing and flavoring their milk containers. After washing the milk containers, 86.1% of the respondents undergo the practice of fumigation (Figure 3).

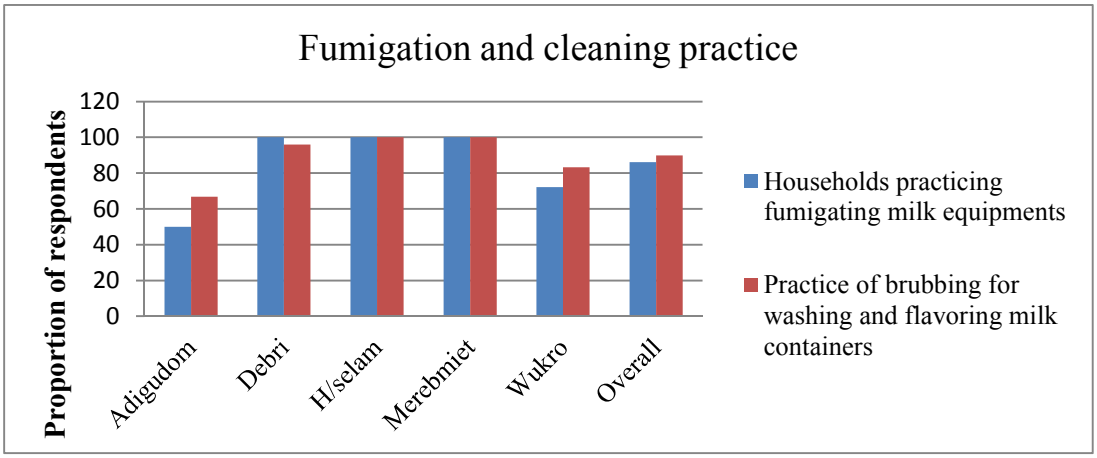

Figure 3. Practice of fumigation and cleaning of milk utensils

The reasons for practicing fumigations were for improving flavor 57%, increasing shelf life (22.8%) and both flavor improvement and shelf life extension 17.7% (Figure 4). The finding of the current study was in line with the report of Fikernehe *et al.* (2012) which stated that the respondents in mid rift valley area of Ethiopia smoke milking utensils to give the product good flavor and aroma and to increase shelf life of the milk and Tesfaye (2007) reported that nearly all inhabitants of Metema district were smoked milk vessels as a traditional preservative method to improve the taste and quality of milk and milk products.

The major plants used for smoking milk equipments were *Acacia etbaica, Olea Africana* and *Trigonella foenumgraecum*(table2). Azage*et al*. (2013) reported that in urban and peri-urban dairy system of (Shashemene–Dilla milkshed), the majority (70%) of the producers smoke their milk utensils with different aromatic plants like Woira *(Olea Africana)* and Tid *(Juniperous Procera)*. This result also agreed with the result of Sintayehu *et al* (2008) who reported milking utensils were smoked with different aroma producing plants like *Olea Africana* and *Juniperous Procera* me study area.

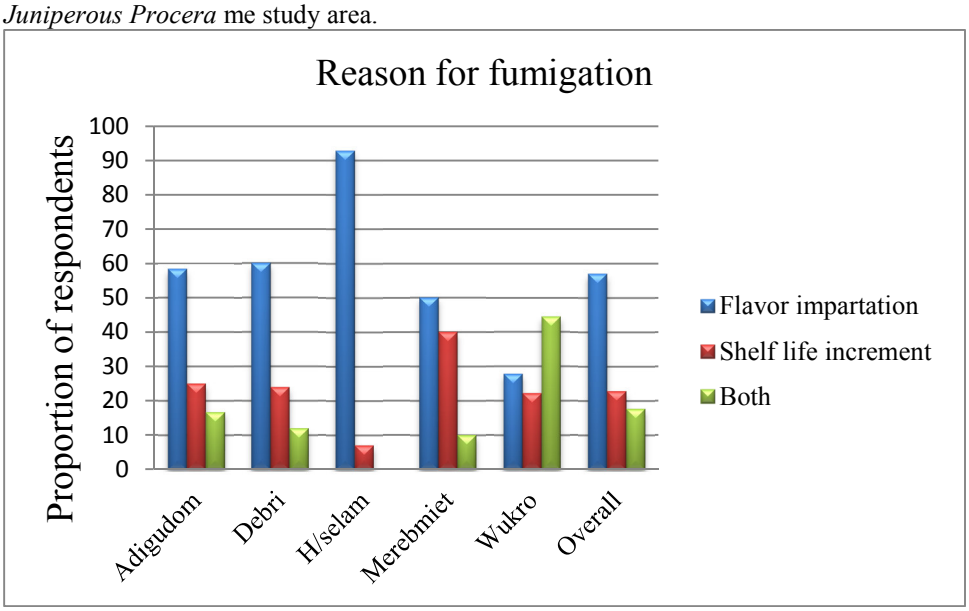

Figure 4. Reason for fumigation practice

Table2. Plant materials used for smoking milk vessels and preserve milk products (%)

Local Name	Common name	Scientific name	Adigudom	Debri	H/selam	Merebmiet	Wukro	Over all
Abish	Fenugreek	*Trigonella foenumgraecum*	100	62.5	64.3	40	25	57.9
Seraw	Acacia	*Acacia etbaica*	83.3	84	100	100	72.2	74.7
Awlie	Olive	*Olea africana*	66.7	64	92.9	100	66.7	64.8

Milk and Milk products production and estimated postharvest loss

The estimations assume only milk that is rejected from sale and milk dumped due to different reasons as post harvest loss. Post harvest loss of milk in the areas from milking to milk delivery ranged from 0 % to 0.42% (table3)

were insignificant when compared for the Sub Saharan Africa which is about 40% (www.fao.org) estimated postharvest loss of milk and its derivatives from milking to consumption.

Table3. Milk and Milk products production and estimated postharvest loss of milk in the households

Milk utilization	Adigudom	Debri	H/selam	Merebmiet	Wukro	Over all
	Mean	Mean	Mean	Mean	Mean	Mean
Weekly milk production (Lit)	85.54	94.5	72.66	81.9	84.98	91.7
Amount of milk sold per week (Lit)	62.56	80.08	50.38	62.1	60.21	73.13
Amount of milk consumed per week (Lit)	8.56	8.36	7.88	5.6	11.25	8.99
Amount of milk rejected from sale per week (Lit)	0	.17	0	.3	.14	.24
Amount of milk dumped per week (Lit)	0	.061	0	.05	0.054	.042
Amount of milk donated to neighbors per week (Lit)	0	.139	.25	.05	.89	.285
Amount of milk processed per week (Lit)	13.67	5.94	13.89	13	12.04	9.84
Amount of fermented milk churned at a time (Lit)	5.44	5.42	8.12	9.4	8.43	7.2
Amount of butter produced per week (Kg)	.56	.85	.49	1.08	1.29	.716
Amount of ayib/cottage cheese produced per week (Kg)	.78	1.61	.75	2	1.16	1.43
Estimated Milk post harvest loss per week (%)	0	.24	0	.42	.23	0.28

Reason for milk spoilage problem

The major possible reasons of milk spoilage in the study areas were poor milk handling practices (78.7%), contamination (33.3%), lack of cooling facilities (41.3%), and lack of technical knowledge (32.4), respectively (Table 4). Diriba *et al*., (2014) confirmed that absence of peri-urban dairy producers and marketing cooperatives, lack of adequate market information; lack of cold storage facilities; repeated interruption of electric power and marketing of adulterated dairy products were the major possible reasons for milk spoilage problem.

Table4. Major possible reasons for milk spoilage problem (%)

Reasons for spoilage	Adigudom	Debri	H/selam	Merebmiet	Wukro	Over all
Poor milk handling practices	0	84	64.3	60	78.6	78.7
Long distance to market	8.3	24	0	30	23.1	17.6
Use of inappropriate containers	0	8	7.1	30	28.6	13.3
Lack of cooling facilities	75	56.2	28.6	10	21.4	41.3
Lack of technical knowledge	50	40	21.4	10	30.8	32.4
Lack of market		7.1	7.1	0	7.1	5.3
Delays of transport		8	7.1	30	28.6	13.3
Adulteration	58.3	40	7.1	0	7.1	25.3
Contamination		52	7.1	20	14.3	33.3

Milk disposal period

The respondents reported that milk loss due to mastitis was high. On the other hand they indicated that infected

udder is treated traditionally, veterinary services and both. The mean disposal period of milk from infected udder was about six days in both districts ranging from 1 to 8 days (table5). The problem of udder infection is serious in many parts of the country. For instance, Lidet *et al*. (2013) reported 52.9% prevalence of udder infection (mastitis) in Areka area Southern Ethiopia; Zenebe *et al*. (2013) reported 64.3% in Adigrat area (Northern Ethiopia), Mekbib *et al*. (2010) reported 71% in Holeta area Central Ethiopia and Abera *et al*. (2013) reported 46.7% in Adama area (South East Ethiopia).

Table5. Disposal period of milk from infected udder (days)

Study town	Disposal period (days)				
	N	Min	Max	Mean	SE
Adigudom	4	2	7	3.75	1.1
Debri	8	1	7	2.63	.73
H/selam	5	2	7	4.4	1.07
Merebmie	5	1	7	4.2	1.2
Wukro	6	3	8	6	.81
Over all	28	1	8	4.11	.45

Table 6 shows the fate of milk from infected udder. Majority 67.3% of the respondents indicated that they dispose milk from infected teats and 12 % reported that they use to feed other animals. These results agree with Melesse *et al*., (2014) reported milk from infected udder disposed in the majority of households and it could be used for animals, human consumption, processed into milk products or used for calves and pet animals in Lume and Ada'a districts

Table6. Fate of milk form infected udder (%)

Fate of milk from infected udder	Adigudom	Debri	H/selam	Mereb miet	Wukro	Over all
Dispose	75	64.3	71.4	62.5	66.7	67.3
Use for animals as feed	0	7.1	37.5	12.5	8.3	12
Use for human consumption	0	4.8	0	0	0	1.6
Process at home	0	0	10	0	0	1.6

Milk production constraints

The major milk production constraints in the study areas were feed shortage (57%), unavailability of improved breeds (60.8%), lack of veterinary service (38%), poor quality feeds (57%) and low milk yield (38%) (table7). Similarly, Million *et al*., (2014) reported that poor production and reproduction potential of dairy associated with poor quality of feed, inefficient AI delivery system and poor conception rate.

The problem of feed shortage is also reported by Galmessa *et al*. (2013) as one of the major factors that hinders urban and peri-urban dairy development in Oromia Region of western Ethiopia. Inadequate supply of quality feed is the major factor limiting dairy productivity in Ethiopia (SNV, 2008). Dairy farmers who use artificial insemination to breed their animals reported a major fertility problem in their dairy herds (Seifu, and Doluschitz, 2014). They indicated a very high service to conception rate in their herd, the cause of which has not yet been identified. Inefficient breeding and inadequate AI service (Galmessa et al., 2013) are among the problems that contribute to underdevelopment of the dairy sector in Western Ethiopia.

Table7. Milk production constraints (%)

Constraints	Adigudom	Debri	H/selam	Merebmiet	Wukro	Over all
Low milk yield	25	28	64.3	40	38.9	38
Poor quality of feeds	41.7	48	85.7	60	55.6	57
Feed shortage	50	60	42.9	60	66.7	57
Low price of milk	58.3	20	21.4	30	22.2	27.8
Poor market infrastructure	33.3	20	14.3	20	27.8	22.8
Labor shortage	33.3	16	21.4	30	22.2	22.8
Unavailability of breed	66.7	64	57.1	30	72.2	60.8
Veterinary service	50	44	28.6	30	33.3	38

Conclusions and Recommendation

Except milking, the majority of the workload for milk handling, processing and marketing was primarily handled by wives. Therefore, division of labor in the dairying households needs improvement. Milking, milk handling and processing was undertaken using traditional equipments and methods that influence the quality as well as safety of the product. Efforts have to take place to improve milking and milk handling as well as processing through awareness creation and utilization of standard utensils, equipments and methods. Majority of dairying households

were found to use different plant materials for the purpose of improving flavor and test of the product and thereby increasing the shelf life. However, the active ingredients of the plant materials and their role in improving test and flavor and also increasing shelf life has to be studied well and the result has to be promoted to an industry level.

Different challenges are constraining the development of the dairy sector in the area. These includes inadequate feeding both in quality and quantity, shortage of AI service, poor veterinary services, poor housing and poor husbandry and management practices, unavailability of improved genotypes and poor genetic makeup of indigenous animals which actually reflected in low milk production.

Therefore, strengthening the dairy extension services in the studied areas through enhancing the input provision system for dairy production like improved breeding, efficient AI services, veterinary services, improved forage, developed infrastructure, capacity building services on milk production and handling, cooperative and marketing are vital.

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